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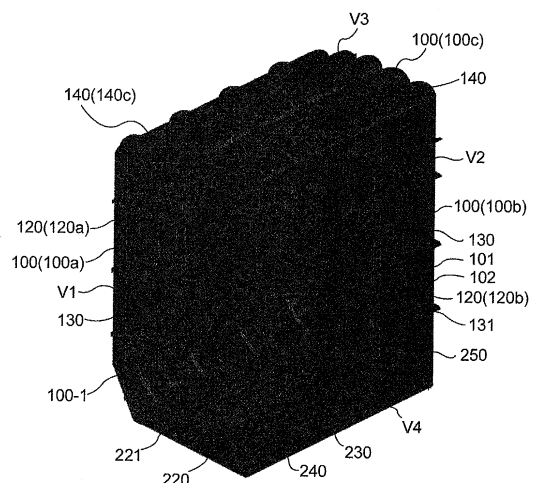
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(54) **PRESSURE CONTAINER FOR LIQUID CARGO STORAGE**

(57) A pressure vessel for storing liquids in bulk which forms a space for storing liquids by combining first reinforcing plates each having a creased cross-sectional structure formed by groove parts and ridge parts with at least one second reinforcing plate having a flat plate cross-sectional structure, in which part of the pressure vessel is formed by the reinforcing plates having the creased cross-sectional structure, thus allowing liquids to efficiently flow in the pressure vessel. The pressure vessel includes: a plurality of first reinforcing plates having a creased cross-sectional structure formed by a groove part and by a ridge part, the first reinforcing plates being combined with each other and forming part of the pressure vessel; and at least one second reinforcing plate combined with the first reinforcing plates and forming a remaining part of the pressure vessel, the one second reinforcing plate having a flat plate cross-sectional structure.

[Fig.6]



Description**Technical Field**

[0001] The present invention relates, in general, to a pressure vessel for storing liquids in bulk, and more particularly, to a pressure vessel for storing liquids in bulk which forms a space for storing liquids by combining a plurality of first reinforcing plates each having a creased cross-sectional structure formed by groove parts and ridge parts with at least one second reinforcing plate having a flat plate cross-sectional structure.

Background Art

[0002] Generally, to transport liquids in bulk, such as liquefied natural gas, from a producing base to a terminal of an accepting base, an LNG carrier is used. The LNG carrier is typically provided with pressure vessels for storing liquids therein.

[0003] FIG. 1 is a front view illustrating the construction of a related art pressure vessel for storing liquefied natural gas (LNG). FIG. 2 is a perspective view illustrating the construction of a reinforcing plate that constitutes the related art pressure vessel.

[0004] To form the pressure vessel V, a plurality of reinforcing plates 10 are combined with each other such that a sealed space S for storing liquids is formed in the pressure vessel V.

[0005] Here, each of the reinforcing plates 10 comprises an external plate 11 having a flat plate structure, and a plurality of reinforcing elements 12 that are mounted to the inner surface of the external plate 11, wherein the function of the reinforcing elements 12 is intended to prevent the external plate 11 from being structurally deformed by a temperature difference generated in the vessel when loading and unloading liquids or by an external force. The reinforcing elements 12 also provide the desired structural strength of the pressure vessel.

[0006] The reinforcing elements 12 comprise a plurality of first reinforcing elements 12a that extend along the axial directions of the external plate, and second reinforcing elements 12b that extend such that they cross the first reinforcing elements 12a at right angles.

[0007] FIG. 3 is a view illustrating an example of bending moment that is induced in the external plate by an internal pressure of the pressure vessel. FIG. 4 is a view illustrating a reduction in the effective width of the external plate, wherein the effective width may be reduced by the cross-section and shear lag effects of the reinforcing elements which may be induced by the internal pressure of the pressure vessel.

[0008] In the pressure vessel formed using the above-mentioned reinforcing plates, the external plate 11 is configured to have a simple flat plate structure, so the bending moment of FIG. 3 is induced in the external plate 11. Accordingly, it is required to arrange the first reinforcing elements 12a at intervals less than 1m.

[0009] In the related art pressure vessel, it is required to arrange the first reinforcing elements 12a at intervals less than 1m, so the pressure vessel is problematic in that the numbers of the first and second reinforcing elements 12a and 12b of the pressure vessel are increased, thereby increasing the production cost and weight of the pressure vessel and reducing the storage capacity of the pressure vessel.

[0010] Further, as shown in FIG. 4, the stress distribution on the flat plate type external plate 11 is uneven, and the height H of the first reinforcing elements 12a is low, so the modulus of section of the first reinforcing elements 12a is low. Further, shear lag effects are generated in the external plate, so the structural strength and rigidity of the reinforcing plates are reduced deteriorating the functional efficiency of the reinforcing plates used as structural elements.

[0011] In an effort to solve the problems, the present applicant developed a reinforcing plate for pressure vessels which has an improved structure. The reinforcing plate developed by this applicant is disclosed in Korean Patent Application No. 2011-0106218.

[0012] FIG. 5 is a perspective view illustrating the construction of a reinforcing plate having a creased cross-sectional structure.

[0013] In the reinforcing plate for pressure vessels according to the above-mentioned invention, an external plate 21 that has a creased structure is provided, in which a plurality of ridge parts 21a are formed in the creased external plate, with first reinforcing elements 22a mounted to the respective ridge parts 21a of the external plate 21.

[0014] The above-mentioned reinforcing plate for pressure vessels is advantageous in that a bending stress that may be induced in the external plate due to the cross-sectional shape of the creased external plate 21 can be changed to a hoop stress, and the bending stress can be reduced in comparison with the related art reinforcing plate having the flat plate type external plate 11. Further, the height of each of the first reinforcing elements is increased by the height of the ridge part of the external plate, so the structural strength and rigidity of the reinforcing plate can be increased and the functional efficiency of the reinforcing plate used as a structural element can be improved.

[0015] However, the pressure vessel that is formed using the reinforcing plates each having the creased external plate is problematic in that liquids stagnate in the groove parts 22a of a reinforcing plate that forms the bottom of the pressure

vessel, so the liquids cannot easily flow. Especially, when unloading the liquids from the pressure vessel, the liquids that stagnate in the groove parts of the reinforcing plate may not be unloaded causing problems.

Documents of Related Art

[0016] (Patent Document 1) Korean Patent Application Publication No. 10-2011-0106218 (2011.09.28)

Disclosure

Technical Problem

[0017] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a pressure vessel for storing liquids in bulk, which is formed by combining reinforcing plates that have a creased cross-sectional structure having groove parts and ridge parts, and in which part of the surfaces of the pressure vessel is formed using reinforcing plates having a flat plate cross-section, so liquids can easily flow in the pressure vessel and the pressure vessel can be easily produced.

[0018] Another object of the present invention is to provide a pressure vessel for storing liquids in bulk, the bottom of which is formed using a reinforcing plate having a flat plate cross-section, so, when unloading liquids from the pressure vessel, the liquids can be easily discharged from the pressure vessel without stagnating in specific parts of the pressure vessel.

[0019] A further object of the present invention is to provide a pressure vessel for storing liquids in bulk, in which, when the pressure vessel is used in a ship having a double-bottomed hull structure, the pressure vessel is configured such that the lower end of a sidewall thereof is shaped as an inclined structure corresponding to the double-bottomed hull structure, thereby realizing a maximum volume capacity of the pressure vessel, and the inclined part is formed at a corner, at which a bottom reinforcing plate having a flat structure meets two side reinforcing plates having a creased structure, in such a way that the inclined part is inclined upward to the two side reinforcing plate, thereby allowing the three reinforcing plates to be naturally and efficiently combined with each other.

Technical Solution

[0020] In order to accomplish the above objects and to overcome the problems experienced in the related art, the present invention provides a pressure vessel for storing liquids in bulk, comprising: a plurality of first reinforcing plates 100 having a creased cross-sectional structure formed both by a groove part 101 and by a ridge part 102, the first reinforcing plates being combined with each other and forming part of the pressure vessel for storing liquids; and at least one second reinforcing plate 200 combined with the first reinforcing plates 100 and forming a remaining part of the pressure vessel, the one second reinforcing plate having a flat plate cross-sectional structure.

[0021] Here, the second reinforcing plate 200 may comprise one second reinforcing plate, wherein the one second reinforcing plate 200 may be installed so as to form a bottom wall V4 of the pressure vessel.

[0022] Here, each of the first reinforcing plate 100 may comprise: an external plate 110, in which the groove part 101 and the ridge part 102 are repeatedly arranged, thereby forming the creased cross-sectional structure; a plurality of first inner reinforcing elements 120 installed on the ridge part 102 such that the first inner reinforcing elements 120 have a structure extending along the ridge part 102 on an inner surface of the external plate 110 and protrude inward in an interior of the pressure vessel; a plurality of second inner reinforcing elements 130 installed on the inner surface of the external plate 110 such that the second inner reinforcing elements 130 cross the plurality of first inner reinforcing elements 120; and a plurality of first outer reinforcing elements 140 installed outside the external plate 110 such that the first outer reinforcing elements form a structure extending along the second inner reinforcing elements 130.

[0023] The pressure vessel may further comprise: a second outer reinforcing element 150 installed outside a first reinforcing plate 100a constituting left/right side walls V1 of the pressure vessel such that the second outer reinforcing element 150 forms a structure continued to a first outer reinforcing element 140c installed on a first reinforcing plate 100c constituting a ceiling wall V3 of the pressure vessel.

[0024] The pressure vessel may further comprise: a face part 131 installed on an end of each of the second inner reinforcing elements 130 so as to increase the strength of the end of the second inner reinforcing element, the face part being formed by two rows of face parts.

[0025] Further, the second reinforcing plate 200 may comprise: an external plate 210 having a flat plate cross-sectional structure; a plurality of first bottom reinforcing elements 220 installed on an inner surface of the external plate 210 such that the first bottom reinforcing elements form a structure continued to first inner reinforcing elements 120a installed on a first reinforcing plate 100a constituting left/right side walls V1 of the pressure vessel, the first bottom reinforcing elements having a plurality of flow holes 221 for allowing liquids to flow through the first bottom reinforcing elements; a plurality

of second bottom reinforcing elements 230 installed on the inner surface of the external plate 210 such that the second bottom reinforcing elements cross the first bottom reinforcing elements 220 so as to form a latticed reinforcing structure and form a structure continued to first inner reinforcing elements 120b that are installed on a first reinforcing plate 100b constituting front/rear walls V2 of the pressure vessel; a plurality of third bottom reinforcing elements 240 installed on the inner surface of the external plate 210 such that the third bottom reinforcing elements form a structure parallel to the second bottom reinforcing elements 230, and are connected to the groove part 101 of the first reinforcing plate 100b constituting the front/rear walls V2 of the pressure vessel; and a connection reinforcing element 250 installed on the groove part 101 of the first reinforcing plate 100b constituting the front/rear walls V2 such that the connection reinforcing element connects ends of the third bottom reinforcing elements 240 to each other, and connects two neighboring first inner reinforcing elements 120b to each other.

[0026] Here, the connection reinforcing element 250 may comprise a plate that extends along a curvature of the groove part 101 while maintaining a constant width.

[0027] Further, the external plate 210 of the second reinforcing plate may comprise an inclined plate that can collect liquids by allowing the liquids to flow down to a desired place when unloading liquids.

[0028] Further, in the pressure vessel, a lower end 100-1 of a first reinforcing plate 100a constituting left/right side walls V1 of the pressure vessel may be inclined inward to an interior of the pressure vessel, and a three-face connecting element 300 may be installed at a corner of the pressure vessel, at which two first reinforcing plates 100a and 100b and the second reinforcing plate 200 meet each other, wherein the three-face connecting element 300 may extend from the second reinforcing plate 200 to the two first reinforcing plates 100a and 100b while being inclined upward, so the two first reinforcing plates 100a and 100b and the second reinforcing plate 200 can be connected to each other by the three-face connecting element.

[0029] Further, the groove parts 101' provided on front and rear ends of a first reinforcing plate 100a constituting left/right side walls V1 of the pressure vessel are configured to form a radius of curvature different from that of other groove parts 101.

Advantageous Effects

[0030] According to the present invention having the above-mentioned characteristics, when manufacturing the pressure vessel for storing liquids in bulk using reinforcing plates having a creased cross-sectional structure, part of the pressure vessel is formed using a reinforcing plate having a flat plate cross-sectional structure, thereby forming a structural environment capable of allowing stored liquids to efficiently flow in the pressure vessel. Particularly, when forming the bottom of the pressure vessel using the reinforcing plate having the flat plate cross-sectional structure, the present invention can prevent liquids from stagnating in specific parts of the pressure vessel when unloading the liquids from the pressure vessel, so the present invention is advantageous in that liquid unloading can be more efficiently performed.

[0031] Another advantage of the present invention resides in that this invention can improve the manufacturing and maintenance efficiency of the pressure vessel.

[0032] Still another advantage of the present invention resides in that, when using the pressure vessel in a ship having a double-bottomed structure, the lower ends of part of the reinforcing plates are configured to be inclined, and a three-face connecting element is provided at a corner at which two reinforcing plates, each having a creased cross-sectional structure, meet one reinforcing plate having a flat plate cross-sectional structure, so the present invention can realize a natural and efficient combination of the three reinforcing plates, can protect the pressure vessel from stress concentration, and can provide a structurally stable pressure vessel.

[0033] A further advantage of the present invention resides in that the reinforcing plates having the creased cross-sectional structure and the reinforcing plate having the flat plate cross-sectional structure are combined with each other using first, second and third bottom reinforcing elements in such a way that the reinforcing plates can maintain structural continuity and the connection reinforcing elements can efficiently distribute stress, so the present invention can realize improved structural stability of the pressure vessel.

Description of Drawings

[0034]

FIG. 1 is a front view illustrating the construction of a related art pressure vessel for storing liquefied natural gas therein; FIG. 2 is a perspective view illustrating the construction of a reinforcing plate constituting the related art pressure vessel; FIG. 3 is a view illustrating a bending moment acting on an external plate by the internal pressure of the pressure vessel;

FIG. 4 is a view illustrating a reduction in the effective width of an external plate by the cross-section of the reinforcing elements and shear lag effects, which is caused by the internal pressure of the pressure vessel;

FIG. 5 is a perspective view illustrating the construction of a reinforcing plate having a creased cross-sectional structure;

FIG. 6 is a perspective illustrating the interior construction of a pressure vessel according to a preferred embodiment of the present invention;

FIG. 7 is a perspective illustrating the exterior construction of the pressure vessel according to the preferred embodiment of the present invention;

FIG. 8 is a perspective illustrating the exterior construction of the pressure vessel according to the preferred embodiment of the present invention, which is viewed from another angle;

FIG. 9 is a perspective view illustrating the construction of a pressure vessel fabricated using only external plates;

FIG. 10 is a front view illustrating the construction of an external plate of a second reinforcing plate having an inclined structure;

FIG. 11 is a detailed view illustrating the installation structure of a connection reinforcing element according to the present invention;

FIG. 12 is a perspective view illustrating the construction of a corner at which two first reinforcing plates and one second reinforcing plate meet each other;

FIG. 13 is a perspective view illustrating the installation structure of a three-face connecting element according to the present invention; and

FIG. 14 is a plan view illustrating the connected structure of two neighboring first reinforcing elements.

Mode for Invention

[0035] Hereinbelow, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. In the following description, it is to be noted that, when the functions of conventional elements and the detailed description of elements related with the present invention may make the gist of the present invention unclear, a detailed description of those elements will be omitted.

[0036] FIG. 6 is a perspective illustrating the interior construction of a pressure vessel according to a preferred embodiment of the present invention. FIG. 7 is a perspective illustrating the exterior construction of the pressure vessel according to the preferred embodiment of the present invention. FIG. 8 is a perspective illustrating the exterior construction of the pressure vessel according to the preferred embodiment of the present invention, which is viewed from another angle. FIG. 9 is a perspective view illustrating the construction of a pressure vessel fabricated using only external plates. FIG. 10 is a front view illustrating the construction of an external plate of a second reinforcing plate having an inclined structure. FIG. 11 is a detailed view illustrating the installation structure of a connection reinforcing element according to the present invention. FIG. 12 is a perspective view illustrating the construction of a corner at which two first reinforcing plates and one second reinforcing plate meet each other. FIG. 13 is a perspective view illustrating the installation structure of a three-face connecting element according to the present invention. FIG. 14 is a plan view illustrating the connected structure of two neighboring first reinforcing elements.

[0037] The pressure vessel for storing liquids in bulk according to the present invention includes a plurality of first reinforcing plates 100 having a creased cross-sectional structure, and at least one second reinforcing plate 200 having a flat plate cross-sectional structure. The present invention can improve the manufacturing and maintenance efficiency of the pressure vessel. The present invention also provides a structural environment that can allow stored liquids to efficiently flow in the pressure vessel without stagnating in specific parts of the pressure vessel, so, when unloading liquids from the pressure vessel, the liquids can be easily discharged from the pressure vessel.

[0038] Further, in FIG. 6, a quarter of the pressure vessel is shown so as one to illustrate the interior construction of the pressure vessel in detail, so only a left side wall, a front wall and a the ceiling wall of the pressure vessel are shown in the drawing. Here, the right side wall and the rear wall are symmetric to the left side wall and the front wall, respectively, so the right side wall and the rear wall are not shown in the drawing. In this drawing, the left/right side walls are designated by reference character V1, the front/rear walls are designated by V2, the ceiling wall is designated by V3, and a bottom wall is designated by V4.

[0039] Each of the first reinforcing plates 100 is configured such that a groove part 101 and a ridge part 102 are repeatedly arranged and form a creased cross-sectional structure. The left/right side walls V1, the front/rear walls V2 and the ceiling wall V3 are formed using the first reinforcing plates 100.

[0040] Further, the first reinforcing plate 100 comprises an external plate 110, a first inner reinforcing element 120, a second inner reinforcing element 130, and a first outer reinforcing element 140.

[0041] The external plate 110 is configured such that the groove part 101 and the ridge part 102 are repeatedly arranged and form the creased cross-sectional structure. Here, the cross-sectional shape of the groove part 101 may be configured as a concave tile shape, an arc shape, a semicircular shape, a semi-elliptical shape, a trapezoidal shape

or a polygonal shape.

[0042] The first inner reinforcing element 120 is installed along the ridge part 102 of the external plate 110, thereby having an extension structure extending along the ridge part 102. Here, the first inner reinforcing element 120 may be installed on each of the plurality of ridge parts 102 of the external plate 110, so the first inner reinforcing element 120 comprises a plurality of elements. The first inner reinforcing element 120 has a structure protruding inward in the pressure vessel.

[0043] The first inner reinforcing element 120 may be formed as an angle steel having a T-shaped or an L-shaped cross-section.

[0044] The second inner reinforcing element 130 is installed on the inner surface of the external plate 110 such that the second inner reinforcing element 130 crosses the plurality of first inner reinforcing elements 120. Here, the second inner reinforcing element 130 comprises a plurality of second inner reinforcing elements 130 that are arranged such that they are spaced apart from each other at regular intervals. A face part 131 that is formed by two rows of face parts is installed on the inner end of each of the second inner reinforcing elements 130 so as to increase the strength of the inner end.

[0045] The first outer reinforcing element 140 is arranged such that it extends along the second inner reinforcing element 130 at a location outside the external plate 110. The first outer reinforcing element 140 comprises a plurality of first outer reinforcing elements 140 in the same manner as that described for the second inner reinforcing element 130.

[0046] In the pressure vessel of this invention, the plurality of groove parts 101 and the plurality of ridge parts 102, which are provided on the first reinforcing plate 100, are connected to each other both by the second inner reinforcing elements 130 and by the first outer reinforcing elements 140. Thus, the first reinforcing plate 100 can avoid deformation caused by a temperature difference generated in the pressure vessel according to unloading of liquids or by an external force applied thereto.

[0047] In other words, in a reinforcing plate having the creased cross-sectional structure, the groove parts and the ridge parts function as reinforcing elements, so the reinforcing plate can efficiently avoid axial deformation. However, the reinforcing plate cannot efficiently resist width-directional deformation, so the groove parts and the ridge parts may expand or contract due to a temperature difference generated in the pressure vessel according to unloading of liquids or by an external force applied thereto. To overcome the problems, in the present invention, the plurality of groove parts 101 and the plurality of ridge parts 102 are connected to each other using both the second inner reinforcing elements 130 and the first outer reinforcing elements 140 as described above, so the first reinforcing plate 100 can avoid deformation caused by expansion and contraction thereof and can provide a pressure vessel having structural stability.

[0048] When the cross-sectional shape of the external plate 110 of the first reinforcing plate 100 having the above-mentioned construction is configured as a concave tile shape, an arc shape, a semicircular shape or a semi-elliptical shape, the bending stress that acts in the external plate 110 due to the pressure of liquids stored in the pressure vessel is changed into hoop stress. However, when the cross-sectional shape of the external plate 110 is configured as a trapezoidal shape or a polygonal shape, the bending stress that acts in the external plate 110 due to the pressure of liquids stored in the pressure vessel can be reduced. Further, the height of the first inner reinforcing element 120 is increased by the height of the ridge part 102, so the present invention is advantageous in that it increases the structural strength and rigidity of the reinforcing plate and reduces the shear lag effects that may be generated in the external plate 110. The construction and operational effects of the first reinforcing plate 100 are disclosed in Korean Patent Application Publication No. 2011-0106218, so a further detailed description of the construction and operational effects of the first reinforcing plate 100 will be omitted from this description.

[0049] The second reinforcing plate 200, which is an element having a flat plate cross-sectional structure, is used to form the pressure vessel in cooperation with the first reinforcing plate 100. It is preferred that the second reinforcing plate 200 be used to form the bottom wall V4 of the pressure vessel. When the bottom wall V4 of the pressure vessel is formed using the second reinforcing plate 200 having the flat plate cross-sectional structure, as described above, it is possible to prevent liquids from stagnating in specific parts of the pressure vessel when unloading the liquids from the pressure vessel, thereby providing an advantage in that liquids unloading can be efficiently performed.

[0050] The second reinforcing plate 200 having the above-mentioned function comprises an external plate 210, a first bottom reinforcing element 220, a second bottom reinforcing element 230, a third bottom reinforcing element 240, and a connection reinforcing element 250.

[0051] The external plate 210 is configured as a flat plate cross-sectional structure. The external plate 210 may be configured as an inclined plate that can efficiently collect liquids by allowing the liquids to flow down to a desired place when unloading liquids. Preferably, the external plate 210 is configured as a V-shaped inclined structure, in which the left and right parts of the external plate 210 are inclined downward to the center of the external plate 210 to form a V-shaped cross-section, so liquids that remain in the left and right parts of the pressure vessel efficiently flow down to the center so as to be collected in the center (see FIG. 10).

[0052] The first bottom reinforcing element 220 is installed on the inner surface of the external plate 210 such that the element 220 extends to the left and right parts of the external plate 110. Here, the first bottom reinforcing element 220

is installed so as to form a structure continued to part of the first inner reinforcing element 120a that is installed on the first reinforcing plate 100a constituting the left/right side walls V1 of the pressure vessel. A plurality of flow holes 221 are formed through the first bottom reinforcing element 220, so liquids can flow through the flow holes 221.

[0053] Here, the first bottom reinforcing element 220 comprises a plurality of first bottom reinforcing elements 220 such that they are connected to the respective first inner reinforcing elements 120a that are provided on the first reinforcing plate 100a constituting the left/right side walls V1.

[0054] The second bottom reinforcing element 230 is installed on the inner surface of the external plate 210 such that the second bottom reinforcing element 230 extends to the front and back and crosses the first bottom reinforcing element 220 so as to form a latticed reinforcing structure. Here, the second bottom reinforcing element 230 is installed to form a structure continued to the first inner reinforcing element 120b that is installed on the first reinforcing plate 100b constituting the front/rear walls V2 of the pressure vessel.

[0055] The second bottom reinforcing element 230 comprises a plurality of second bottom reinforcing elements 230 such that they are connected to the plurality of first inner reinforcing elements 120b that are provided on the first reinforcing plate 100b constituting the front/rear walls V2.

[0056] The third bottom reinforcing element 240 is installed on the inner surface of the external plate 210 such that the third bottom reinforcing element 240 forms a structure parallel to the second bottom reinforcing element 230. The end of the third bottom reinforcing element 240 is connected to the groove part 101 of the first reinforcing plate 100b that constitutes the front/rear walls V2 of the pressure vessel.

[0057] The third bottom reinforcing element 240 comprises a plurality of third bottom reinforcing elements 240 such that at least one third bottom reinforcing element 240 can be placed between two neighboring second bottom reinforcing elements 230. In FIG. 6, a structure in which two third bottom reinforcing elements 240 are installed between two neighboring second bottom reinforcing elements 230 is illustrated.

[0058] The connection reinforcing element 250 is installed on the groove part 101 of the first reinforcing plate 100b that forms the front/rear walls V2. The connection reinforcing element 250 connects the ends of the third bottom reinforcing elements 240 to each other, and connects two neighboring first inner reinforcing elements 120 to each other.

[0059] The connection reinforcing element 250 functions to distribute stress that concentrates on the junction between the third bottom reinforcing element 240 and the first reinforcing plate 100b. Preferably, the connection reinforcing element 250 comprises a plate that extends along the curvature of the groove part 101 while maintaining a constant width (see FIG. 11).

[0060] Further, on an outer surface of the first reinforcing plate 100a that constitutes the left/right side walls V1 of the pressure vessel, a second outer reinforcing element 150 may be installed. Here, the second outer reinforcing element 150 has a structure that is continued to the first outer reinforcing element 140c that is installed on the first reinforcing plate 100c constituting the ceiling wall V3 of the pressure vessel.

[0061] Further, in the present invention, to realize a desired volume capacity of the pressure vessel, it is preferred that the lower end 100-1 of the first reinforcing plate 100a constituting the left/right side walls V1 of the pressure vessel be configured to form an inclined structure that is inclined inward to the interior of the pressure vessel such that the lower end 100-1 corresponds to the double-bottomed structure of a ship.

[0062] However, when the lower end 100-1 of the first reinforcing plate 100a that constitutes the left/right side walls V1 of the pressure vessel is configured to form an inclined structure as described above, an inferior quality structure may be formed at a corner of the pressure vessel, at which the first reinforcing plate 100a constituting the left/right side walls V1, the first reinforcing plate 100b constituting the front/rear walls V2, and the second reinforcing plate 200 constituting the bottom wall V4 meet each other, as shown in FIG. 12, so the corner may be difficult to repair or maintain and a stress may concentrate on the corner to cause a structural defect (see FIG. 12).

[0063] To overcome the above-mentioned problems, in the pressure vessel of the present invention, a three-face connecting element 300 is installed at the corner of the pressure vessel, at which two first reinforcing plates 100a and 100b and one second reinforcing plate 200 meet each other, so the two first reinforcing plates 100a and 100b and the second reinforcing plate 200 can be connected to each other at the corner so as to form a natural and efficient structure.

[0064] Here, the three-face connecting element 300 is installed in such a way that it is inclined upward from the second reinforcing plate 200 both to the first reinforcing plate 100a constituting the left/right side walls V1 and to the first reinforcing plate 100b constituting the front/rear walls V2. In the present invention, respective groove parts 101 of two neighboring first reinforcing plates 100a and 100b can be naturally, efficiently connected to each other using the three-face connecting element 300 (see FIG. 13).

[0065] Further, respective groove parts 101' which are provided on the front and rear ends of the first reinforcing plate 100a constituting the left/right side walls V1 of the pressure vessel may be configured to form a radius of curvature different from that of the other groove parts 101 (see FIG. 14).

[0066] Hereinbelow, the operational effects of the above-mentioned pressure vessel for storing liquids in bulk will be described.

[0067] In the pressure vessel for storing liquids in bulk according to the present invention, the left/right side walls V1,

the front/rear walls V2 and the ceiling wall V3 are formed using the first reinforcing plates 100 having the creased cross-sectional structure. Accordingly, the bending stress that acts in the external plate 110 of the first reinforcing plate 100 can be changed to a hoop stress or can be efficiently reduced by the cross-sectional shape of the external plate 110, thereby improving the structural stability of the pressure vessel. Further, in the present invention, the height of the first inner reinforcing element 120 is increased by the height of the ridge part 102, and the stress is evenly distributed on the external plate having the creased cross-sectional structure without generating shear lag effects that may be generated in the external plate having the flat plate cross-sectional structure, so the present invention efficiently increases the effective width of the first inner reinforcing element 120 and increases the structural strength of the first inner reinforcing element 120. Therefore, in comparison with the related art pressure vessel using the reinforcing plates having the flat plate cross-sectional structure, the present invention can increase the interval between the reinforcing elements and reduces the number of reinforcing elements used in the pressure vessel, thereby reducing the production cost and the raw material cost of the pressure vessel.

[0068] Further, when the bottom wall V4 of the pressure vessel is formed using the second reinforcing plate 200 having the flat plate cross-sectional structure, liquids may efficiently flow without stagnating in specific parts of the bottom wall V4, so liquids unloading work can be easily performed. Further, the present invention can realize easy production, repair and maintenance of the pressure vessel.

[0069] Further, in the present invention, desired structural continuity at the junction between the first reinforcing plate 100 and the second reinforcing plate 200 can be realized using the first inner reinforcing element 120 and the second inner reinforcing element 130. Further, the stress that may be generated in the junction between the first inner reinforcing element 120 and the first reinforcing plate 100b can be evenly distributed using the connection reinforcing element 250, so the pressure vessel of the present invention can realize desired structural stability.

[0070] Further, when the lower end of the first reinforcing plate 100a that constitutes the left/right side walls V1 of the pressure vessel is configured to form an inclined structure that corresponds to the double-bottomed structure of a ship, the three-face connecting element 300 is installed at a corner at which the two first reinforcing plates 100a and 100b meet the second reinforcing plate 200, so the two first reinforcing plates 100 can be naturally and efficiently connected to the second reinforcing plate 200. Thus, the present invention is advantageous in that it can easily produce a pressure vessel and can prevent stress from concentrating on the corner due to an inferior quality structure of the corner.

[0071] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

<Description of the Reference Numerals in the Drawings>

[0072]

100:	first reinforcing plate	101:	groove part
102:	ridge part	110:	external plate
120:	first inner reinforcing element		
130:	second inner reinforcing element		
140:	first outer reinforcing element		
150:	second outer reinforcing element		
200:	second reinforcing plate		
210:	external plate		
220:	first bottom reinforcing element		
221:	flow holes		
230:	second bottom reinforcing element		
240:	third bottom reinforcing element		
250:	connection reinforcing element		
300:	three-face connecting element		

Claims

1. A pressure vessel for storing liquids in bulk, comprising:

a plurality of first reinforcing plates (100) having a creased cross-sectional structure formed both by a groove

part (101) and by a ridge part (102), the first reinforcing plates being combined with each other and forming part of the pressure vessel for storing liquids; and
 at least one second reinforcing plate (200) combined with the first reinforcing plates (100) and forming a remaining part of the pressure vessel, the one second reinforcing plate having a flat plate cross-sectional structure.

2. The pressure vessel for storing liquids in bulk as set forth in claim 1, wherein the second reinforcing plate (200) comprises one second reinforcing plate, the one second reinforcing plate (200) being installed so as to form a bottom wall (V4) of the pressure vessel.

3. The pressure vessel for storing liquids in bulk as set forth in claim 2, wherein each of the first reinforcing plate (100) comprises:

an external plate (110), in which the groove part (101) and the ridge part (102) are repeatedly arranged, thereby forming the creased cross-sectional structure;

a plurality of first inner reinforcing elements (120) installed on the ridge part (102) such that the first inner reinforcing elements (120) have a structure extending along the ridge part (102) on an inner surface of the external plate (110) and protrude inward in an interior of the pressure vessel;

a plurality of second inner reinforcing elements (130) installed on the inner surface of the external plate (110) such that the second inner reinforcing elements (130) cross the plurality of first inner reinforcing elements (120); and

a plurality of first outer reinforcing elements (140) installed outside the external plate (110) such that the first outer reinforcing elements form a structure extending along the second inner reinforcing elements (130).

4. The pressure vessel for storing liquids in bulk as set forth in claim 3, further comprising:

a second outer reinforcing element (150) installed outside a first reinforcing plate (100a) constituting left/right side walls (V1) of the pressure vessel such that the second outer reinforcing element (150) forms a structure continued to a first outer reinforcing element (140c) installed on a first reinforcing plate (100c) constituting a ceiling wall (V3) of the pressure vessel.

5. The pressure vessel for storing liquids in bulk as set forth in claim 3, further comprising:

a face part (131) installed on an end of each of the second inner reinforcing elements (130) so as to increase a strength of the end of the second inner reinforcing element, the face part being formed by two rows of face parts.

6. The pressure vessel for storing liquids in bulk as set forth in claim 2, wherein the second reinforcing plate (200) comprises:

an external plate (210) having a flat plate cross-sectional structure;

a plurality of first bottom reinforcing elements (220) installed on an inner surface of the external plate (210) such that the first bottom reinforcing elements form a structure continued to first inner reinforcing elements (120a) installed on a first reinforcing plate (100a) constituting left/right side walls (V1) of the pressure vessel, the first bottom reinforcing elements having a plurality of flow holes (221) for allowing liquids to flow through the first bottom reinforcing elements;

a plurality of second bottom reinforcing elements (230) installed on the inner surface of the external plate (210) such that the second bottom reinforcing elements cross the first bottom reinforcing elements (220) so as to form a latticed reinforcing structure and form a structure continued to first inner reinforcing elements (120b) that are installed on a first reinforcing plate (100b) constituting front/rear walls V2 of the pressure vessel;

a plurality of third bottom reinforcing elements (240) installed on the inner surface of the external plate (210) such that the third bottom reinforcing elements form a structure parallel to the second bottom reinforcing elements (230), and are connected to the groove part (101) of the first reinforcing plate (100b) constituting the front/rear walls (V2) of the pressure vessel; and

a connection reinforcing element (250) installed on the groove part (101) of the first reinforcing plate (100b) constituting the front/rear walls (V2) such that the connection reinforcing element connects ends of the third bottom reinforcing elements (240) to each other, and connects two neighboring first inner reinforcing elements (120b) to each other.

7. The pressure vessel for storing liquids in bulk as set forth in claim 6, wherein the connection reinforcing element

(250) comprises a plate that extends along a curvature of the groove part (101) while maintaining a constant width.

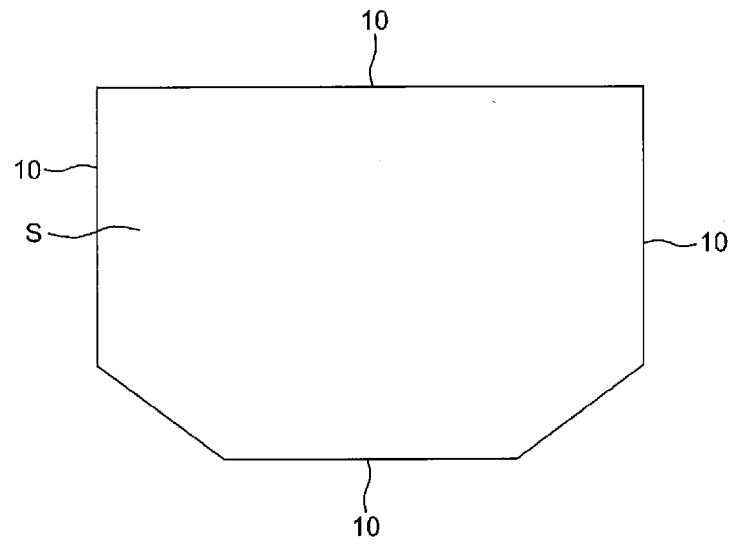
8. The pressure vessel for storing liquids in bulk as set forth in claim 6, wherein the external plate (210) comprises an inclined plate that can collect liquids by allowing the liquids to flow down to a desired place when unloading liquids.

9. The pressure vessel for storing liquids in bulk as set forth in claim 2, wherein
a lower end (100-1) of a first reinforcing plate (100a) constituting left/right side walls (V1) of the pressure vessel is inclined inward to an interior of the pressure vessel, and
a three-face connecting element (300) is installed at a corner of the pressure vessel, at which two first reinforcing plates (100a and 100b) and the second reinforcing plate (200) meet each other, wherein the three-face connecting element (300) extends from the second reinforcing plate (200) to the two first reinforcing plates (100a and 100b) while being inclined upward, so the two first reinforcing plates (100a and 100b) and the second reinforcing plate (200) are connected to each other by the three-face connecting element.

10. The pressure vessel for storing liquids in bulk as set forth in claim 2, wherein groove parts (101') provided on front and rear ends of a first reinforcing plate (100a) constituting left/right side walls (V1) of the pressure vessel are configured to form a radius of curvature different from that of other groove parts (101).

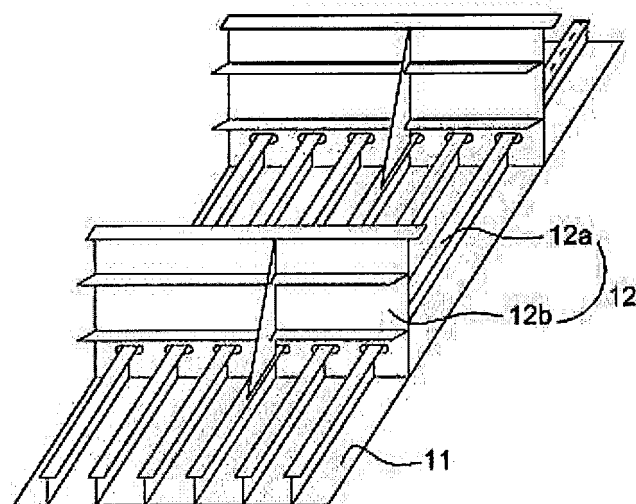
[Fig.1]

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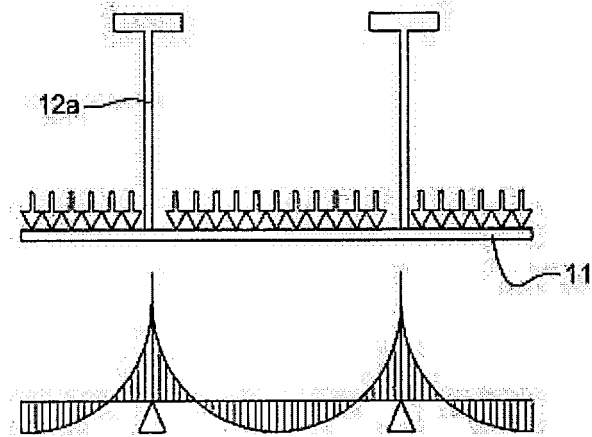


[Fig.2]

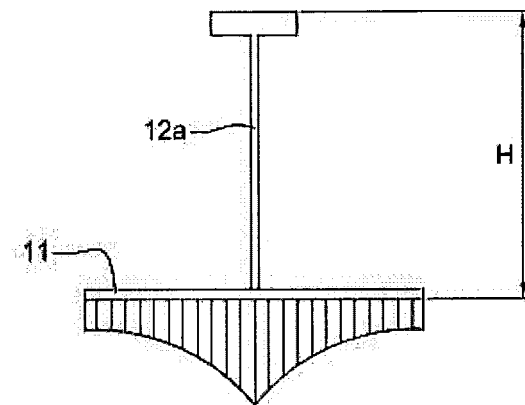
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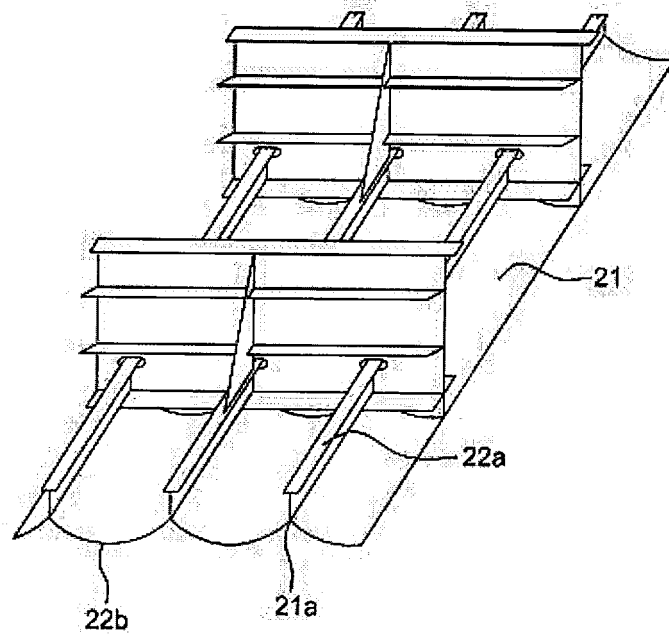
[Fig.3]



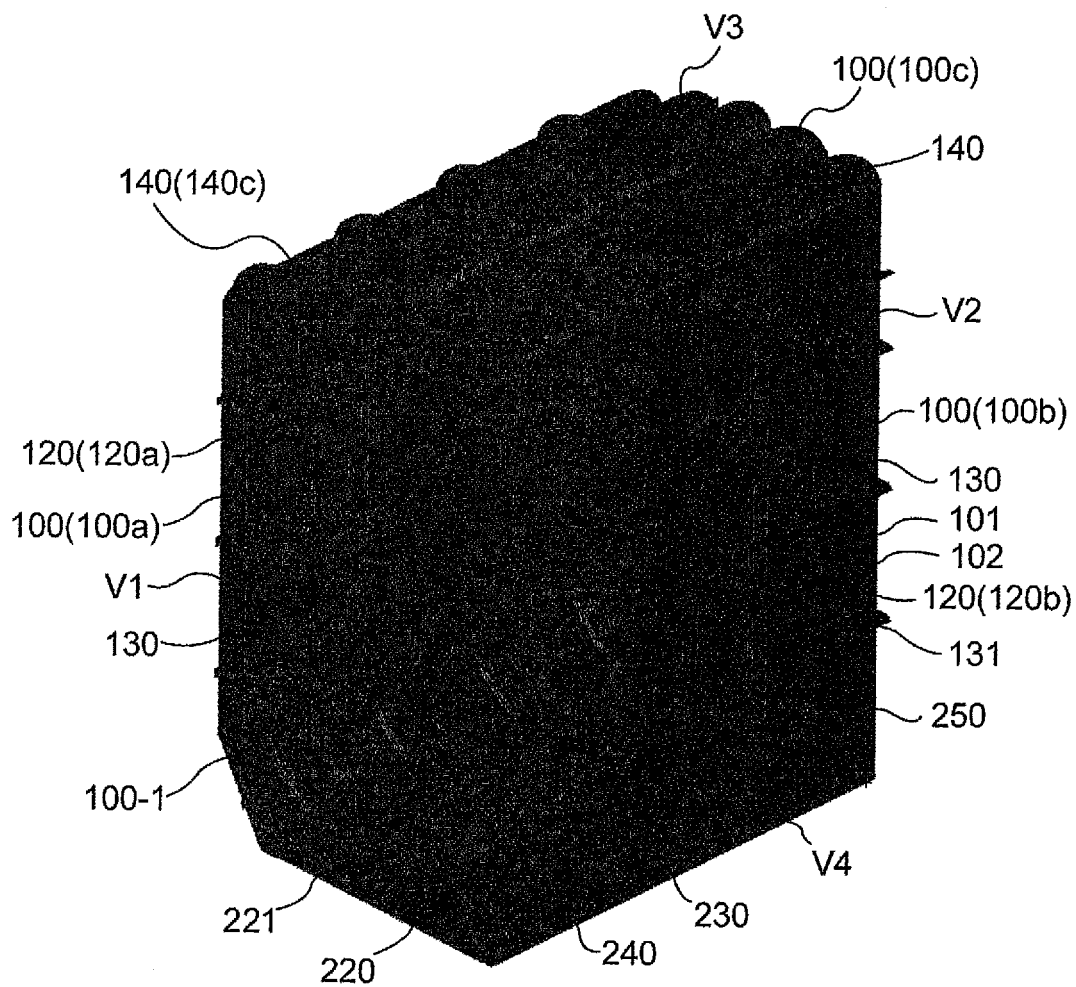
[Fig.4]



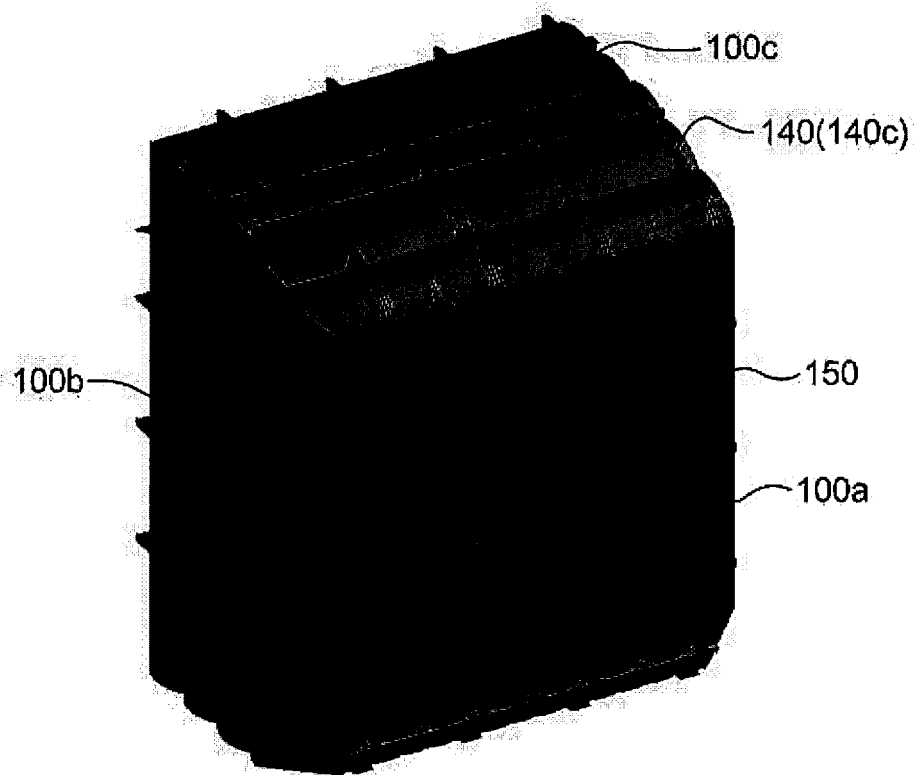
[Fig.5]



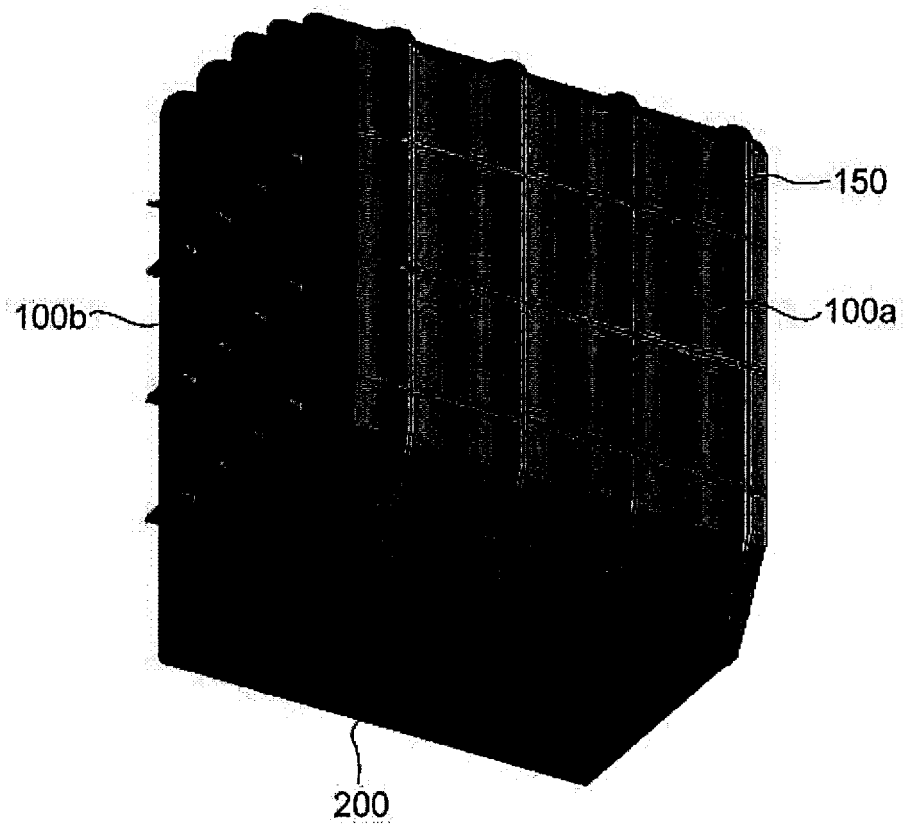
[Fig.6]



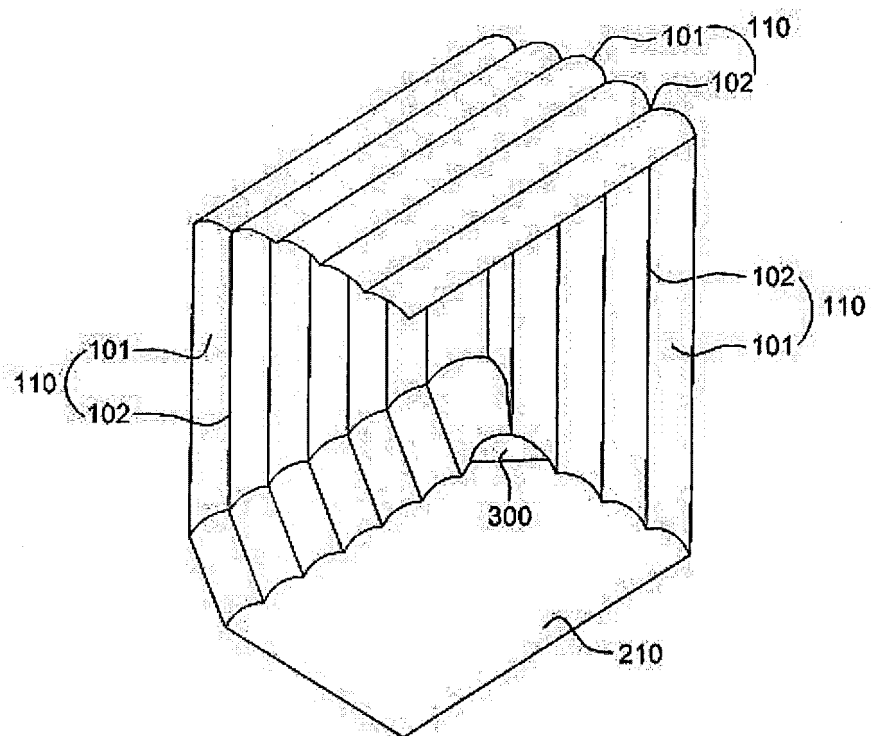
[Fig.7]



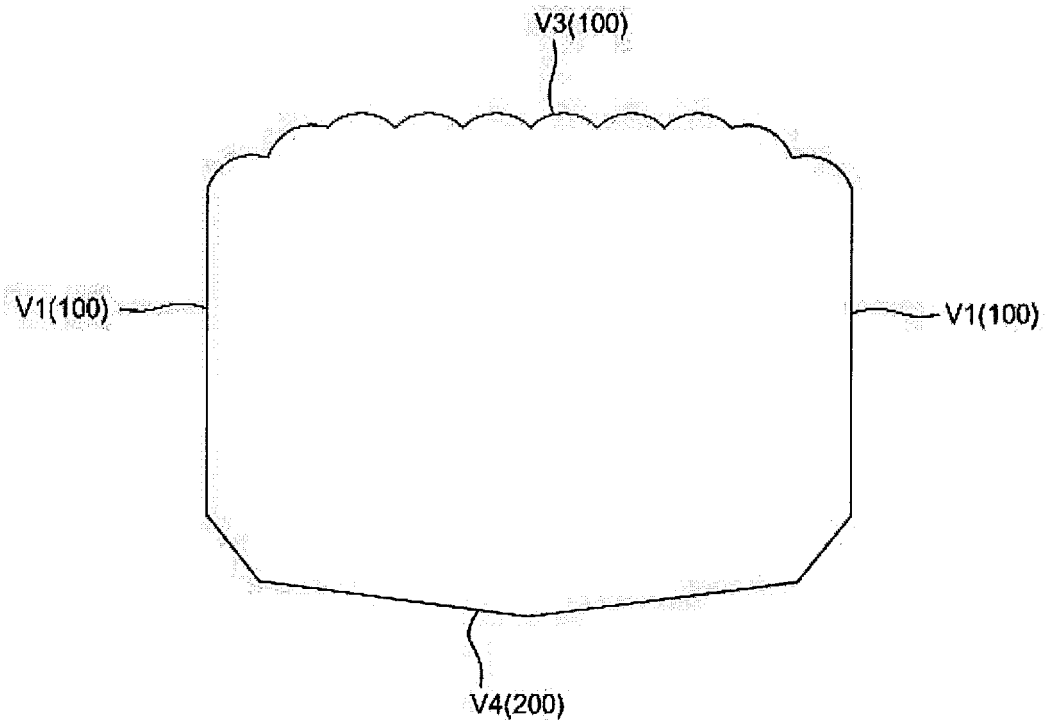
[Fig.8]



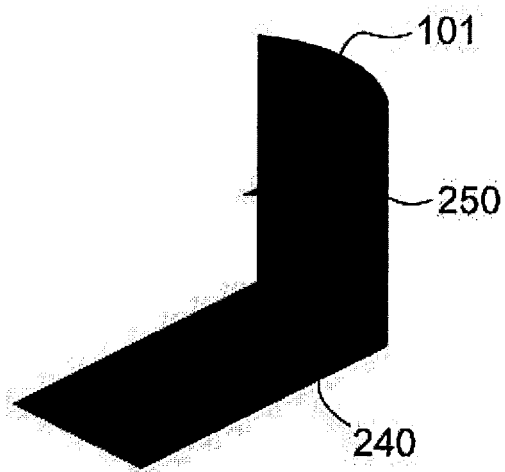
[Fig.9]



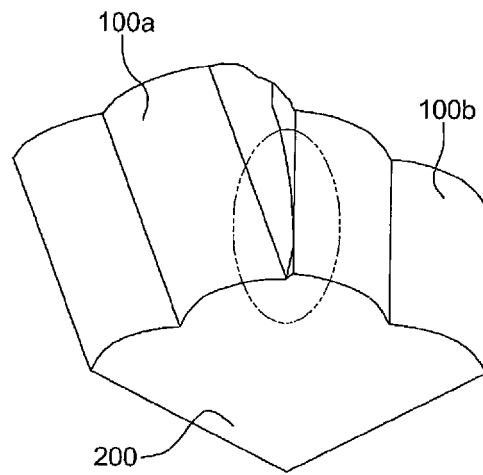
[Fig.10]



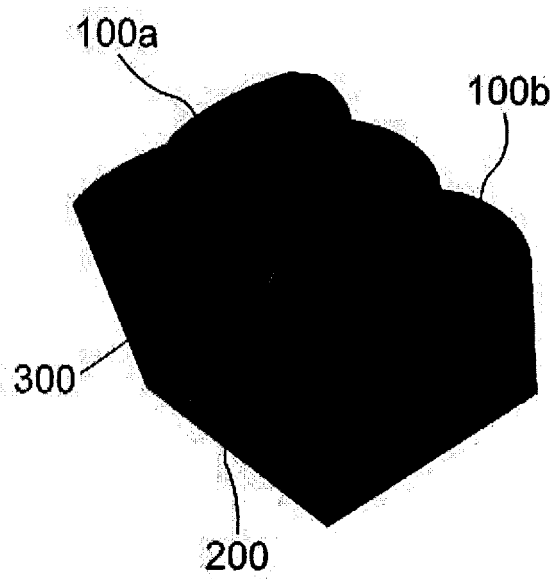
[Fig.11]



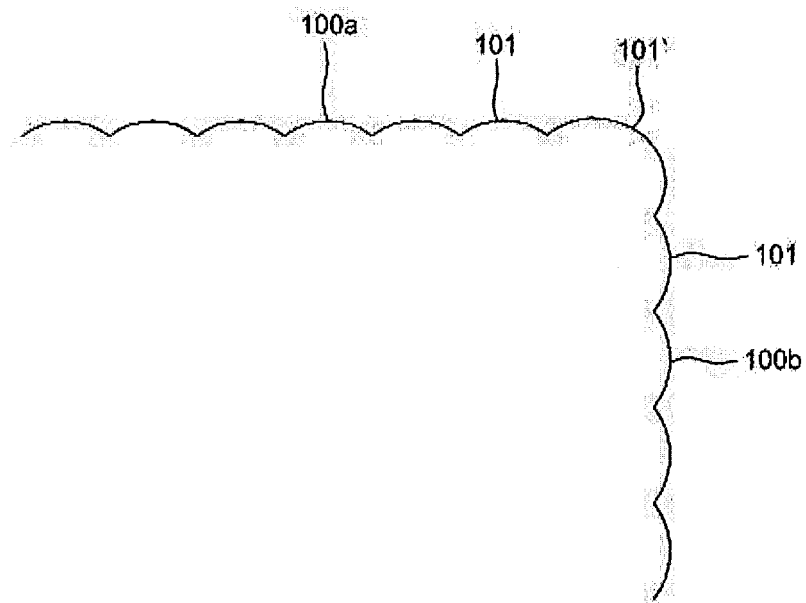
[Fig.12]



[Fig.13]



[Fig.14]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2013/007357

A. CLASSIFICATION OF SUBJECT MATTER

F17C 1/08(2006.01)i, F17C 1/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F17C 1/08; B63B 3/62; B63B 3/36; B63B 3/22; F17C 1/04; F17C 1/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models: IPC as above

Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: first stiffening plate, ribs, second stiffening plate, flat plate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2011-0106218 A (HYUNDAI HEAVY INDUSTRIES CO., LTD.) 28 September 2011	1-5,9,10
A	See abstract, pages 5-7, figures 2a, 5a.	6-8
Y	JP 62-175289A (MITSUI ENG & SHIPBUILD CO LTD) 31 July 1987	1-5,9,10
A	See pages 1, 2, figures 1-5.	6-8
A	JP 2002-012182 A (MITSUBISHI HEAVY IND LTD) 15 January 2002	1-10
	See abstract, pages 3-6, figure 7.	

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

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Date of the actual completion of the international search

21 OCTOBER 2013 (21.10.2013)

Date of mailing of the international search report

22 OCTOBER 2013 (22.10.2013)

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Patent document cited in search report	Publication date	Patent family member	Publication date
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JP 2002-012182 A	15/01/2002	NONE	

REFERENCES CITED IN THE DESCRIPTION

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- KR 20110106218 [0011] [0048]
- KR 1020110106218 [0016]